number, the two upper long, narrow and adjacent, the 3rd is a flattened dome-like mass, the 4th is long and curving inwards. Behind this at a short distance is the second row, consisting of fourteen very minute, closely arranged, thin, longer or shorter tooth-like processes, those on the upper side being slightly the largest.

Major diam. 0·35 ; minor diam. 0·32 ; alt. axis 0·2 inches.

Hab.—This very interesting new form was also obtained by Mr. Ogle near Brahmakhund, eastern Assam, at 1,000 feet elevation.

The arrangement of the internal barriers is unlike any species of this sub-genus I have yet examined, and shews a decided departure from the usual North-East Frontier forms, a sort of foreshadow that in the mountains further east this particular development is to be found of a like or more marked character.

In external form the present species resembles *P. shiroiensis*, but may be distinguished from it by the coarser epidermis and more regular striation, and the broader wider size of the last whorl near the aperture, shewing no constriction. It is of interest to note that the flattened dome-like barrier on the palatal or mantle side coincides with the vertical barrier in *P. shiroiensis* where we see the distinct result of two teeth fused as it were together.

This species should come in after No. 18, *P. refuga*, var. *dextrorsa*, as a sub-section *b′* of group B of the key in P. Z. S. Palatal vertical *plicæ* only compound, in two rows, numerous. Horizontal parietal *laminæ* short.

II.—*On the Operations for obtaining the Discharges of the large Rivers in Upper Assam, during Season* 1877-78.—*By* Lieut. H. J. Harman, R. E., *in charge Assam Valley Series, Survey of India. Communicated by* Major-Genl. J. T. Walker, R. E., C. B., F. R. S., *Surveyor General of India.*

[One of the Survey Operations during the field season of 1877-78 was to explore as much as possible of the region between the Subansiri and the Dihang Rivers, with a view to ascertaining which of these two affluents of the Brahmaputra river had the best claim to be considered the recipient of the Sanpo River of Thibet. As there was reason to fear that political difficulties might intervene to prevent the survey officers from proceeding a sufficient distance into the interior to settle this disputed point, Lieut. Harman was directed to measure the discharges of the several rivers at various points, and to ascertain the volume of water in each river in order that additional evidence might be forthcoming on an interesting geographical problem. The following paper gives the details of these operations.

J. T. W.]

The first river measured was the Subansiri. The method of procedure was as follows, and the same method of work was adopted for all the other rivers :

A gauge-post was planted in the bed of the stream to note the variation in level of the water during the operations. Four parallel lines were laid out across the river, at a perpendicular distance apart of 758 ft., the shore portions of the lines being marked by flags (vide fig. 1).

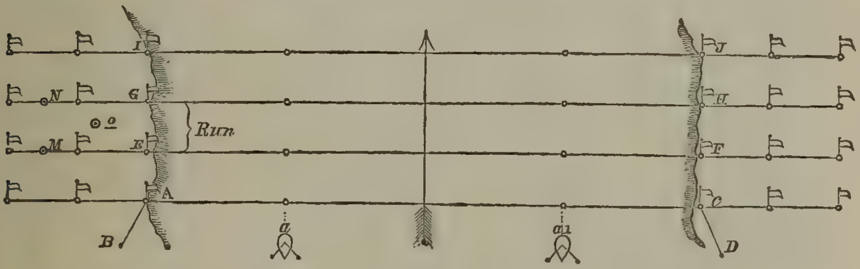

Fig. 1.

Base lines A B and C D were measured, and on a plane table a chart was made on the scale of 70 feet = 1 inch showing the lines of flags and the margins of the river. The section was obtained in the following manner:

A small dug-out (canoe) was anchored at (*a*) and the cable eased off until the observer (myself) in the boat was exactly on the upper or first line A C. A signal was made to an assistant stationed with the plane table at *B* or *D*, who at once cut in the position of the observer in the boat on the line A C. Soundings were then taken, and the boat let down to the 2nd line or upper line of the "Run." The position of the observer in the boat was again cut in and soundings were taken ; and so on for the remaining two lines. The boat was then hauled up, the grapnel raised, and a new position (a_1) taken up.

It was found that in most cases, the line joining the four sounding stations obtained from one anchoring position, closely agreed in direction with the surface flow of the water at that part of the river.

The instruments for measuring velocities were discs of wood 3 in. diameter and $\frac{1}{4}$ in. thick, marked by a little mass of cotton wool thrown over a peg standing upright in the centre of the disc (fig. 2). Also tin tubes, 1 in. diameter, closed at one end, varying in length from $2\frac{1}{2}$ to 10 ft., containing enough water to sink the tubes, so that only 3 or 4 inches

Disc.

Fig. 2.

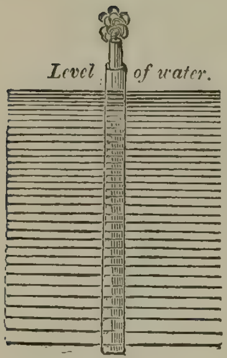

Fig. 3.

of them remained above water (fig. 3). In the mouth of the tube was a cork and some cotton wool for a marker. I obtained from Calcutta a number of hollow balls 3 in. diameter, for sub-surface velocity measurements: I did not get them till February and found that unfortunately they were defective and were of little use to me.

I had also a current-meter by "Casella," with which I intended observing sub-surface velocities. Capt. Willans, R. E., Executive Engineer, Shillong, very kindly designed and had made up for me an effective apparatus, a lift by which the current meter could be lowered and fixed to any desired depth in the water, could be started and stopped at pleasure, and raised easily to allow of the record being read off. Unfortunately, when too late, I found that the meter would not work except with a very high velocity of water, and those records obtained were untrustworthy.

The method of measuring the velocity was as follows:—

The boat was moored on the upper line A C (vide Fig. 1), and the floating instruments dropped into the water. The general line of direction taken by the floats was observed with a prismatic compass; on the bank were two observers M and N, each furnished with a good pair of binoculars. A recorder, with a large chronometer (Dent's) beating half seconds, was seated at *O*.

The flag staves were thin and straight. When the observer M saw a float cross his line E F he cried "*past*," and the recorder at *O* noted the time in his book: when the float passed the line G H, the observer *N* cried "past" and the recorder noted the time. The interval between the two noted times, gives the time taken by the float to pass over the "Run."

The following example shows the method of computation adopted in the majority of cases: of course it sometimes happened that the section of the bed of the river between adjacent sections where velocities were taken was as in fig. 4, or the direction of the flow of the water at *a* differed greatly from that at *b*, or the observations at one of the Sections were untrustworthy; in such cases modifications were necessary and methods recommended by one's judgment were resorted to; but the following example gives the type of computation adopted in most cases:—

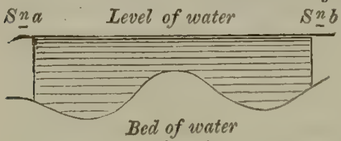

Fig. 4.

The length of run = 50 feet.

From chart the length $c\,e$ = 200 feet (vide Fig. 5). Make c G = Ge.

Through G draw G K, showing a mean direction of flow of floats, *i. e.* 265°.

Draw f G h perpendicular to G K and the lines cf, eh perpendicular to $f\,g\,h$.

Then for computation of discharge ; the area of the section from c to e is very nearly

$$\left[200 \times \text{Cos } 9^\circ \times \left(\frac{12 + 10}{2}\right)\right] = \text{A}.$$

From the velocity measurements—

The meantime of passage of 10 discs thrown in at c = 12·5
6 tubes, each 10 ft. long, at c = 14·5
4 „ „ 3 ft. long, at c = 12·0
.... of 12 discs thrown in at e = 12·0
4 tubes, each 8 ft. long, at e = 14·5
3 „ „ 3 „ at e = 12·0

Assumed meantime of passage for section is 13·5—

The mean velocity per second required for section is $\frac{50 \times \text{sec. } 9^\circ}{13{\cdot}5} = \text{V}$,

and AV = discharge, or number of cubic feet of water passing through c to e in one second of time.

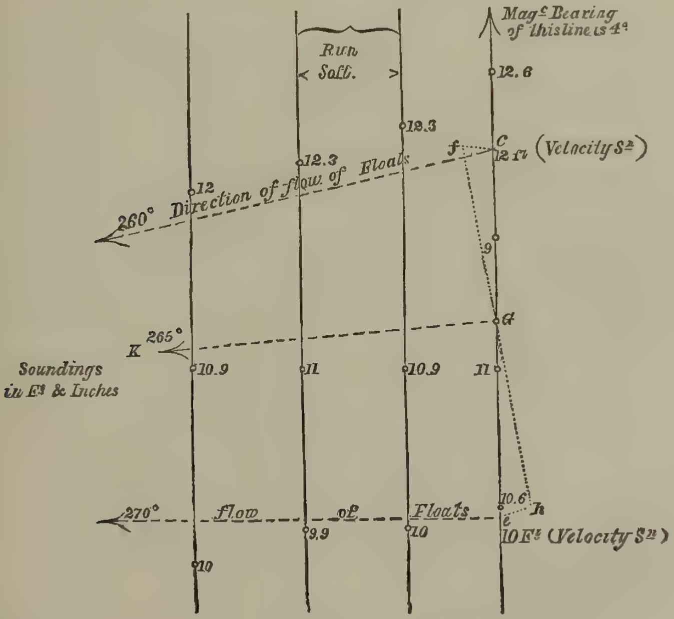

Fig. 5.

There is a clumsiness in the formula, but no alteration has been made, because I set up all the quantities for giving the discharges before it was noticed. The values of the discharges are not affected, but I may as well note how the formula took its shape.

Let M N O P (Fig. 6) be an open channel of considerable length, the flow of water uniform, the section of the channel rectangular.

Let cd and ef be two lines parallel to each other, at a perpendicular distance apart equal to gh. ab is a section at right angles to length of tube and to the direction of flow of water.

Let the angle $cgi = 90° + \theta$, and v be the depth.

Let t be the time in seconds taken by a particle of water to move from g to K.

Then the Discharge through the section $cd = \dfrac{cd \times v \times gh}{t}$.

The Discharge through $ab = cd \times \cos\theta \times v \times \dfrac{gh \text{ sec. } \theta}{t}$ (1) $= \dfrac{cd \times v \times gh}{t}$

It is this formula (1) which has been employed.

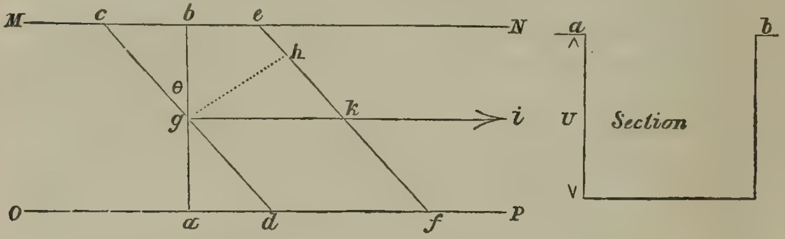

Fig. 6.

(a) The line of maximum velocity of a river is found at a short distance below the surface. The velocity at the bottom of a river is less than the surface velocity ; the retardation is great if there are many weeds.

The bottoms of all the rivers measured were of coarse heavy sand, excepting a short stretch of big pebbles in the bed of the combined Dihang and Dibang rivers.

Professor Rankine assumes that the mean velocity on a vertical line, is to the greatest velocity on the same line, as 3 to 4 for slow rivers and 4 to 5 in rapid streams.

The velocity of a rod extending to nearly the bed of the stream is approximately the mean velocity of the water in the vertical plane traversed by the rod. In assigning a mean velocity for computation to the several portions of the sections of the rivers, all the above facts were kept in view.

At some sections of observation for determining velocity, many different instruments were used and many passages made ; at other sections only a few observations were made.

(*b*) The arithmetical mean of the times noted at a station of the passages of a certain floating instrument, was taken as the mean time of passage of that instrument. The record of times was kept to half seconds, and it is rarely that discrepancies of over 1 second from the mean occur. These discrepancies were due, first to errors of observation and 2ndly to considerable divergence of the floating instrument from the general line taken. Having obtained at a station the mean time of passage of each kind of instrument, and having regard to the number and quality of the observations, a value was assumed as representing the mean time of passage of the water at that station.

For the adjacent station, a mean time of passage was obtained in a similar manner. Then for the whole included section, a value was assumed as representing the mean time of passage, and this value was employed in the computation.

In such a case as the following: at station (*a*) the velocity of the water is high, and the swift water extends nearly to the adjacent station *c*, and shows a well defined margin-line of the current. At station *c* the velocity is low.

In such cases the section from station (*a*) to station (*c*) is sub-divided into 2 parts; the swift water portion is dealt with by itself, the remaining part by itself.

The method adopted of obtaining the data for computation gives, I think, the results required, and without much labour.

(*c*) The Flood Discharges are merely probable values. They were obtained in the following way. The section lines were laid down on the Revenue Survey large-scale maps of the rivers. An examination was made on the ground to see what changes had taken place since the maps were made. All vertical heights on these flood sections (shown on charts of river sections) were estimated. The flood section was then divided into portions, and an assumed velocity was assigned to each portion, the value being chiefly determined by the section of the portion, its position, and from what local information I could gather. The main-stream high flood velocity has been taken at 7 feet per second. To obtain the total Flood Discharge it was necessary to increase the velocities of each portion of the dry season section. After once assuming values for the flood velocities of the different portions, no alterations were made subsequently.

(*d*) Some of the rivers measured, were above the mean low-level of the dry season. To obtain the discharge of the river at its mean low-level of the dry season, the following method was adopted: the area of each portion of the section, due to rise, was computed and subtracted from the observed area of that portion; then, to the diminished area of the portion, a mean velocity was given which was less than the observed mean velocity of the portion. After velocities have been once assumed they have not been reconsidered or altered.

In the case of the reduction of the observed discharge of the Dibang river, to its mean low-level discharge of the dry season, the rise of water was taken as 4 feet, but subsequently it was taken as 5 feet.

The depths along the section of the Brahmaputra above Sadiya were all obtained on the same day. The velocity observations at some of the stations were made when the river had risen 1 foot to 1½ feet: reductions were therefore made to the observed velocities at these stations.

(*e*) The columns in the Synopsis Table, headed "Mean Velocity of river at its mean low-level of the year," and at "high flood level," do not contain much information unless they are compared with the sectional areas, and form of section.

The sum of the discharges of the rivers forming the Brahmaputra river should equal the discharge of the Brahmaputra itself. The work done fulfils this test sufficiently nearly to allow, I think, of the stated discharges being considered as sufficiently approximate for geographical purposes.

The Subansiri measurements were made between the 25th and 28th of February 1878. The weather was fine for the work, the level of water constant; very little wind disturbed the observations. The boatmen and others living at the site of the section stated that the water was very rarely seen at a lower level, and that during the observations it was at the dead-low of the dry season.

Ninety soundings were made to obtain the section of the stream; at 21 stations observations were taken for velocity and there were 510 recorded passages of the floating instruments. The resulting discharge at lowest level of the year was found to be 16,945 cubic feet per second: the superficial area of the section 9,637 superficial feet, so that the mean velocity of the water was 1·7 feet per second.

During the very high floods of the year the water is known to rise 22 feet, but calculations have been made for ordinary high flood, taken at 16 feet; with this rise of water I have computed the discharge to be at least 170,000 cubit feet per second; area of section is 35,700 superficial feet, so that mean flood velocity is 4·7 feet per second.

For extreme floods, 13,000 superficial feet must be added to the section area and 70,000 cubic feet to the discharge, which would bring the maximum discharge up to 240,000 cubic feet per second, and sectional area to 48,700 superficial feet.

The site of the section was at Pathalipam village, 3 miles west of Gogah-muk ferry, and about 10 miles from the foot of the hills, from the gorge where the river issues out into the plains.

Before issuing into the plains, the river flows gently for 9 miles in a great chasm; the depth of the water may be taken at 60 feet, (the few soundings taken were 66 to 70), mean width 90 yards, and velocity fully 1 foot per second. Such dimensions give a discharge equal to the measured discharge; but I am of opinion that had I selected my site at the place where the river leaves the hills, I should have obtained a greater discharge than the one I measured, on account of loss by percolation through the sand.

The Subansiri after leaving the hills spreads out into several sandy channels, which unite above Gogah-muk. At Gogah-muk the river flows in one channel and turns abruptly from a north to south course into a west by north course.

The next river measured was the Brahmaputra river, at a site due north of, and 3 miles distant from Dibrugarh Church. There was a rise in the river just before the measurements were made, but the work was done at the low level of the year, and the observations were made at favorable times. On account of the wind and the rapidity of the current, the work occupied me from March 11th to 18th. In the rapid parts of the river, where the velocity was 5 feet per second, a light canoe manned by four men could not make way up-stream, and it was therefore generally necessary to have the boat brought in shore, poled up-stream and then dropped down into position: a position once missed could only be regained by going in shore again.

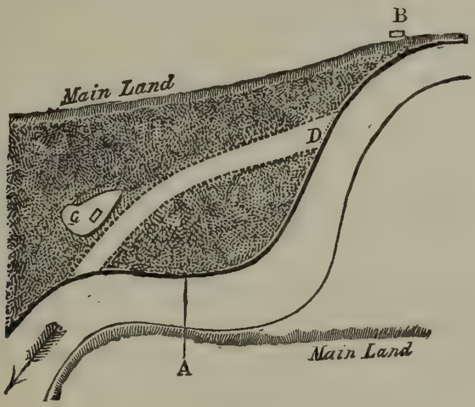

Fig. 7.

The site selected, though favourable for the operations, unfortunately did not include the entire volume of the river: the blunder happened in this way:

Between the site *A*, (Fig. 7) and the Miri village of Saenga Jan (B) is a distance of 3 miles. During the cold season of 1876-77 there was a wide channel D in the sands, its mouth was choked with sand; a little way down the channel the water was less than knee-deep and the flow very slight.

Before commencing work I sent men to see the channel and they reported it shallower than it was in the preceding year: just before closing work I found that at the village *C* the channel was wide, breast deep and the flow slow. To allow for this unmeasured percolation through the sands I have added to the measured discharge of the Brahmaputra 3000 cubic feet per second to bring the result nearer the truth. The "Buri Suti" channel for two miles from its mouth has no water in it, but at 15 miles from its mouth it is rarely fordable.

After the work was finished on March 19th there was a rise of 6 feet in the river, and at Gauháti on March 24th it caused the gauge register to read 4.6 ft. above the zero.

For the section, 120 soundings were taken: observations for velocity were made at 14 stations, and there were 255 recorded passages of the floating instruments.

The resulting discharge at the low level of the year was found to be 113,115 cubic feet per second; the superficial area of section was 24,477 superficial feet, so that the mean velocity of the water was 4.6 feet per second. To the observed discharge, 3,000 cubic feet must be added for percolation through the sands and flow through the channel D, mentioned above, thus bringing the discharge up to 116,115 cubic feet per second.

During very high floods the water rises 20 feet, but calculations have been made for an ordinary high flood rise of 16 feet, which gives a discharge exceeding 830,000 cubic feet per second, a sectional area of 164,000 superficial feet, so that the mean velocity of the flood is 5 feet per second.

For an extreme flood the discharge would exceed 1,100,000 cubic feet per second, and the sectional area 208,000 superficial feet. For a rise of 3 feet over the low level of the year, the increased section would be 14,100 superficial feet and the increased discharge 54,000 cubic feet per second.

The next river measured was the united stream of the Dihang and Dibang rivers, at one mile above the junction with the Brahmaputra and one mile below the mouth of the Dibang river. At the time of measurement the river was somewhat less than 3 feet above the low level of the year.

The weather was fairly favourable and the site selected was a good one. The work was done between March 24th and 27th of 1878.

For the section, 59 soundings were taken, observations for velocity were made at 12 stations, and there were 170 recorded passages of floating instruments.

The resulting discharge was 110,011 cubic feet per second, sectional area 25,105 superficial feet, so that the mean velocity was 4·4 feet per second.

The river at time of measurement was 3 feet above the minimum level of the year. The increased section due to this 3 feet rise, is computed to be 6,222 superficial feet, and the increased discharge to be 27,359 cubic feet per second; thus the cold weather low-level discharge of the united streams is 82,652 cubic feet, sectional area 18,883 superficial feet, mean velocity 4·3 feet per second.

To obtain the cold weather low level discharge of the Dihang river it is necessary to subtract the Dibang discharge, shown below to be 27,200 cubic feet per second, and this quantity subtracted from the discharge of the united streams will give the Dihang discharge to be 55,400 cubic feet per second at minimum level of the year.

During very high floods the united rivers rise 20 feet, but the calculations have been made for an ordinary high flood rise of 15 feet which gives a discharge of 485,000 cubic feet per second, a sectional area of 84,000 superficial feet and consequent mean velocity of 5·7 feet per second.

To obtain the flood discharge of the Dihang river, it will be necessary to subtract that of the Dibang river which is shown below to be 122,483 cubit feet per second, which amount subtracted from the above 485,000 cubic feet leaves for the ordinary flood discharge of the Dihang river 362,517 cubic feet per second.

The next river measured was the Dibang river at one mile above its mouth and half a mile below the mouth of the Senseri river.

The work was done on the 27th March 1878 when the river was 5 feet above the low level of the year. This river receives a good deal of snow-water, from snowy mountains close to the plains. After a hot day the river will rise during the night 2 to 3 feet, subsiding during the morning. This is not the case in the Dihang river.

There were 37 soundings taken for the section. At 9 stations observations were made for velocity, and there were 116 recorded passages of floating instruments.

The measured discharge was 47,383 cubic feet per second, sectional area 10,992, and therefore mean velocity 4·3 feet per second. But at time of measurement the river was 5 feet above minimum level of the year, and this 5 feet rise has been computed to produce an increased sectional area of 4,617 superficial feet and discharge of 20,181 cubic feet.

Thus the discharge of the Dibang river + Senseri river at the low level of year is 27,202 cubic feet per second, sectional area 6,375 superficial feet and mean velocity 4·2 feet per second. But the Senseri river brings down about 1,200 cubic feet, so that the low level discharge volume of the Dibang river is 26,000 cubic feet per second.

During the high floods the river rises 20 feet, but like the Dihang computations an ordinary flood of 15 feet has been calculated for, and then the flood discharge is 122,483 cubic feet per second, sectional area 23,692 superficial feet, and mean velocity 5·2 feet per second.

For an extreme flood of 18 feet, the discharge would exceed 144,000 cubic feet, the sectional area be 27,700 superficial feet, and mean veloclty 5·2 feet per second.

The next river measured was the Brahmaputra river at about 9 miles above Sadiya and half a mile below the mouth of the united stream of the Tengapáni aud Noa Dihing rivers. There was a good deal of difficulty found in the measurement of this river on account of bad weather and the level of the water not remaining constant. The section was made when the river was at 3 feet above the low level of the year, but most of the velocities were measured when the river was at a slightly higher level. These facts were kept in view when the calculations were made.

The measurements were made between April 2nd and 6th of 1878. For the section, 61 soundings were made, observations for velocity were taken at 14 stations, and there were 165 recorded passages of floating instruments.

The measured discharge was 66,251 cubic feet per second, sectional area 16,396, so that the mean velocity was 4 feet per second. At time of measurement the river was 3 feet above the minimum level of the year : the increased volume due to this rise was computed to be 32,419 cubic feet per second, and sectional area 8,168 superficial feet ; so that the mean low-level dry season discharge of the Brahmaputra river below Tengapáni-muk is 33,832 cubic feet per second, sectional area 8,228 superficial feet, and, consequently, mean velocity 4·1 feet per second.

To obtain the minimum discharge of the Brahmaputra at the Brahmakund, it will be necessary to deduct from the above figures, the cold season mean low-level volume of the Tengapáni and Noa Dihing (which is stated below to be 3,000 cubic feet per second), and that of the Digaru river which I would estimate from hearsay at 5,000 cubic feet per second. Thus the minimum discharge of the Brahmaputra at the Brahmakund would be 25,000 cubic feet per second.

The ordinary high flood of the Brahmaputra below Tengapáni-muk has been calculated at 16 feet. It gives a discharge of 293,000 cubic feet per second, a sectional area of 53,017 superficial feet and mean velocity of flood 5·5 feet per second. For the flood discharge at the Brahmakund one should subtract from above discharge 53,000 cubic feet for the Tengapani and Noa Dihing rivers (vide below), and I would estimate 60,000 for the Digáru river, which would leave 180,000 cubic feet per second for flood discharge of the Brahmaputra at the Brahmakund.

For an extreme flood of 18 feet the discharge below Tengapáni-muk would be over 326,000 cubic feet per second, sectional area 59,000 superficial feet and mean velocity 5·5 feet per second ; then calculating by proportion, the extreme flood of the Brahmaputra at the Brahmakund would be not less than 200,000 cubic feet per second.

Before closing work at Tengapáni-muk I thought it well to make a measurement of the united stream of the Tengapáni and Noa Dihing rivers. This I did on the 6th April 1878 at a site 200 yards below the junction of the Tengapáni and Noa Dihing rivers. At the time of measurement the water was fully 3 feet above mean low level of the year, and more than half of it came from the Noa Dihing river.

For the section 18 soundings were made, observations for velocity were taken at 2 stations and there were 19 recorded passages of the floating instruments.

The measured discharge was found to be 6,807 cubic feet per second, sectional area 2,203 superficial feet, mean velocity 3·1 feet per second.

At the time of measurement the river was 3 feet above minimum level of the year ; it is computed that for the low level of the year the discharge is 3,000 cubic feet, area of section 900 superficial feet, and velocity 3·3 feet per second ; and of this 3,000 cubic feet, 2,500 cubic feet comes from the Tengapáni river.

For an ordinary high flood rise of 15 feet, the discharge is computed to be 53,000 cubic feet per second, sectional area 10,400 superficial feet and mean velocity 5·1 feet per second.

For an extreme flood rise of 18 feet, the discharge is 65,000 cubic feet, sectional area 12,800 superficial feet and mean velocity 5·1 feet per second.

From the Synopsis Table attached, it will be seen how closely the sum of the volumes &c. observed, for the two great streams which form the Brahmaputra River, agree with the observed volume of the river at Dibrugarh. . The river at Dibrugarh should be of greater volume than the combined Dihang and Sadiya streams, because of the Lali channel of the Dihang which joins in just below the place where the section of the Dihang and Dibang was taken. During the cold season, and at time of observations it was a small and fordable stream 100 yards wide, but during floods the channel brings down a very large volume of water.

During the floods a considerable volume of water passes down the Buri Suti, the mouth of which is on the north bank and between Dibrugarh and the mouth of the Dihang river.

The Buri Suti falls into the Brahmaputra near the mouth of the Dihing river, south of Dibrugarh.

I have endeavoured to be as moderate as possible in my estimates of the flood discharges, but I think it may fairly be stated that at Poba, a few miles above the mouth of the Buri Suti, there is every season a flood when 1½ million cubic feet per second passes down the Brahmaputra. The rise of the flood I have calculated at 15 to 18 feet. The rise at Gauháti is 28 to 30 feet.

Synopsis Table. Results of

Name of River.	Discharge in cubic ft. per second at mean low level of the year.	Sectional area in Sup. ft. at mean low level of the year.	Mean velocity in feet per second at mean low level of the year.	Discharge at ordinary High Floods.	Sectional area at ordinary High Floods.	Mean velocity in feet per second at ordinary High Floods.	Discharge at extreme High Floods.
Dihang + Dibang River,..	82,652 (*d*)	18,883 (*d*)	4·3 (*d*)	485,000 (*d*)	84,000 (*d*)	5·7 (*d*)	567,000 (*e*) (18 ft. rise)
Brahmaputra River, above Sadiya and below mouth of the Tengapáni River.	33,832 (*d*)	8,228 (*d*)	4·1 (*d*)	293,000 (*d*) (16 ft. rise)	53,017 (*d*) (16 ft. rise)	5·5 (*d*)	326,000 18 ft. (*e*)
Total,....	116,484	27,111	4·2 about	778,000	137,017	5·6 about	893,000
Brahmaputra River at Dibrugarh. *	116,115 (*o*)	24,477 (*o*)	4·6 (*o*)	830,000 (*d*)	164,000	5·0	1,100,000 (*e*)
Difference,....	—369	....	....	+ 52,000	....	....	+107,000
Dibang River, below mouth of Senseri River.	27,202 (*d*)	6,375 (*d*)	4·2 (*d*)	122,483 (*d*)	23,692 (*d*)	5·2 (*d*)	144,000 18 ft. rise
Senseri River, ...	1,200 (*e*)	....	....	12,000 (*e*)	....	....	14,000 (*e*)
Dihang River (less the Lalisuti.)	55,400 (*d*)	....	....	362,517 (*d*)	....	....	423,000 (*e*) 18 ft. rise
Tengapáni + Noa Dihing,	3,000 (*d*)	900 (*d*)	3·3 (*d*)	53,000 (*d*) 15 ft. rise	10,400 (*d*) 15 ft. rise	5·1 (*d*)	65,000 (*e*) 18 ft. rise
Tengapáni River, ...	2,500 (*e*)	....	....	22,000 (*e*)	....	....	26,000 (*e*)
Noa Dihing River, ...	500 (*e*)	....	....	....	....	....	....
Digáru River, ...	5,000 (*e*)	....	....	60,000 (*e*)	....	....	75,000 (*e*)
Subansiri River, ...	16,945 (*o*)	9,637 (*o*)	1·7 (*o*)	170,000	35,700	4·7	240,000
Brahmaputra at the Brahmakund.	25,000 (*d*)	....	....	180,000 (*d*) 16 ft. rise	....	..	200,000 (*d*) 18 ft. rise

Note: (*o*) means observed value.
(*d*) „ deduced value by computation.
(*e*) „ estimated value.

Discharge Measurements.

Sectional area at extreme High Floods.	Mean velocity in feet per second at extreme High Floods.	Measured discharge of River, when it was 3 ft. above mean low level of year.	Measured Sectional area when river was 3 ft. above mean low level of year.	Observed mean velocity when river was 3 ft. above mean low level of the year.	Date of Measurements.	Site of Section.	No. of Soundings taken for Section.	No. of Stations at which observations were made for velocity.	No. of recorded Passages of Floating Instruments.	Remarks.
98,000 (*e*) (18 ft. rise)	5·8 (*e*) (18 ft. rise)	110,011 (*o*)	25,105 (*o*)	4·4 (*o*)	1878. 24th to 27th March	1 mile S. of mouth of Dibang river & 1 mile above junction with Brahmaputra.	59	12	170	
59,000 (*e*) (18 ft. rise)	5·5 (*e*)	66,251 (*o*)	16,396 (*o*)	4·0 (*o*)	April 3rd to 6th.	9 miles above Sadiya and ¼ of a mile below the mouth of the Tengapani River.	61	14	165	* Vide Memoir, Page 15.
157000	5·7 about	176,262	41,501	4·2 about						
208000 (*e*)	5·3 (*e*)	170,915	38,500	4·4	March 16th, 17th, 18th.	at a place due N. of and 3 miles from Dibrugarh.	120	14	255	
....	....	—5,347	....	....						
27,700 (18 ft. rise)	5·2	47,383 (*o*) at 5ft. above mean low level of the year.	10,992 (*o*) at 5 ft. above mean low level of the year.	4·3 (*o*) at 5 ft. above mean low level of the year.	March 27th.	¼ mile below the mouth of the Senseri River.	37	9	116	
....	....	....	....	....	....					
....	....	....	....	....	....					
12,800 (*e*) (18 ft. rise)	5·1 (*e*)	6,807 (*o*)	2,203 (*o*)	3·1 (*o*)	April 6th.	200 yards below junction of Tengapani River with Noa Dihing River.	18	2	19	
....	....	2,500 (*e*)	....	....	....					
....	....	4,307 (*e*)	....	....	....					
....	....	....	....	....	....					
48,700	4·9	....	....	....	....					
....	....	....	....	....	Febr. 25th to 28th.	Pathalipam village, 3 miles west of Gogah Muk.	90 385	21 72	510 1,235	

H. J. HARMAN, LIEUT. R. E.
Survey of India.

October, 1878.

SUBANSIRI RIVER.

Computations of Discharge.

Observations taken February 26th, 27th, 28th of 1878.
Length of Run 50 feet. Magnetic Bearing of Section lines 330°.

Station Nos. at extremity of each portion. (1)	Depth at Station. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth of portion for Computation. (5)	Observed flow of floats at Stations. (Mag.) (6)	Angle of Flow of Water for Computation. (7)	Mean time of Passage of Floats at Stations. (8)	Mean time of Passage, for Computation. (9)	Multiplication.	Area of portion. (10)	Discharge per second through portion. (11)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
left bank to 63	0 4	140	140	2	.. ..	..	35	40·0	$140 \times 2 \times \frac{50}{40}$	280	350
63 to 62	4 7	75	74	5·5	.. 250°	8°	35 24	30·0	$74 \times 5{\cdot}5 \times \sec. 8° \times \frac{50}{30}$	407	685
62 to 64	7 9	78	77	8	250° 255°	12½°	24 20	22·0	$77 \times 8 \times \sec. 12\frac{1}{2}° \times \frac{50}{22}$	616	1,434
64 to 44	9 10	34	34	9·5	255° 255°	15°	20 19·5	19·75	$34 \times 9{\cdot}5 \times \sec. 15° \times \frac{50}{19{\cdot}75}$	323	847
44 to 45	10 10·5	42	41	10·25	255° ..	16°	19·5 21·0	20·25	$41 \times 10{\cdot}25 \times \sec. 16° \times \frac{50}{20{\cdot}25}$	420	1,079

45 to 61	10·5 12	64	63	11·25	.. 262°	20°	21·0 22·0	21·50	63 × 11·25 × sec. 20° × $\frac{50}{21·50}$	709	1,755
61 to 41	12 10	117	114	11	262° 260°	21°	22·0 28·0	25·0	114 × 11 × sec. 21° × $\frac{50}{25}$	1,254	2,686
41 to 46	10 12	30	30	11	260° 261°	20½°	28·0 29·0	28·50	30 × 11 × sec. 20½° × $\frac{50}{28·50}$	330	618
46 to 58	12 11	44	44	11·5	261° 257°	19°	29·0 29·0	29·0	44 × 11·5 × sec. 19° × $\frac{50}{29}$	506	923
58 to 47	11 9	76	75	10	257° 260°	18½°	29·0 31·0	30·0	75 × 10 × sec. 18½° × $\frac{50}{30}$	750	1,318
47 to 65	9 11·5	72	71	10·25	260° 252°	16°	31·0 35·0	33·0	71 × 10·25 × sec. 16° × $\frac{50}{33}$	728	1,147
65 to 48	11·5 11·75	15	15	11·6	252° 254°	13°	35·0 37·0	36·0	15 × 11·6 × sec. 13° × $\frac{50}{36}$	174	248
48 to 66	11·75 12·0	21	21	11·8	254°	13°	37·0 42·0	39·5	21 × 11·8 × sec. 13° × $\frac{50}{39·5}$	248	322
66 to 49	12·0 11·75	43	43	11·9	.... 252°	12°	42·0 48·5	45·25	43 × 11·9 × sec. 12° × $\frac{50}{45·25}$	512	578
49 to 42	11·75 11·50	34	34	11·6	252° 253°	13°	48·5 47·0	47·50	34 × 11·6 × sec. 13° × $\frac{50}{47·50}$	394	426

SUBANSIRI RIVER,—*Continued.*

Station Nos. at extremity of each portion. (1)	Depth at Stations. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth of portion for Computation. (5)	Observed flow of floats at Stations. (Mag.) (6)	Angle of Flow of Water for Computation. (7)	Mean time of Passage of Floats at Stations. (8)	Mean time of Passage, for Computation. (9)	Multiplication.	Area of portion. (10)	Discharge per second through portion. (11)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
42 to 50	11·50 12·0	27	27	11·75	255° 248°	11°	47·0 45·0	46·0	27 × 11·75 × sec. 11° × $\frac{50}{46}$	317	351
50 to 67	12·0 12·25	55	54	12	248° ····	8°	45·0 36·0	40·5	54 × 12 × sec. 8° × $\frac{50}{40·5}$	648	808
67 to 43	12·25 12·00	40	40	12·25	···· 247°	7°	36·0 36·0	36·0	40 × 12·25 × sec. 7° × $\frac{50}{36}$	490	686
43 to 51	12·00 11·75	12	12	11·9	247° 242°	4°	36·0 32·0	34·0	12 × 11·9 × sec. 4° × $\frac{50}{34}$	143	211
51 to 52	11·75 9·25	18	18	10·5	242° ····	····	32·0 42·0	37·0	18 × 10·5 × $\frac{50}{37}$	189	255
52 to 53	9·25 7·00	13	13	8·0	···· ····	····	42·0 50·0	46·0	13 × 8 × $\frac{50}{46}$	104	113

53 to right bank	7·0 0·0	27	27	3·5	....	....	50·0	50·0	$27 \times 3{\cdot}5 \times \frac{50}{50}$	95	95
									Total, ...	9,637	16,945

Width of water 1,070 feet. Mean velocity = 1·7 ft. per second.
For Flood Discharge, rise 16 feet, width of water 2,120 feet. Divide it into 4 parts,—

One of 600 feet in width, having a flood velocity of 7 feet per second, gives a discharge of 600 × 16 × 7, ...	67,000
One of 500 feet, depth 16 feet, velocity 6 feet per second, 500 × 16 × 6, ...	48,000
One of 500 feet, mean depth 12 feet, velocity 5 feet per second, 500 × 12 × 5, ...	30,000
One of 500 feet, mean depth 5 feet, velocity 3 feet per second, 500 × 5 × 3, ...	8,000
Flood Discharge, in cubic feet, per second, about, ...	153,000
To above measured discharge, add measured discharge, ...	16,945
Total Flood Discharge at ordinary High Flood, ...	170,000

Area of Section = 35,700 superficial feet, and mean velocity of flood = 4·7 feet per second.

H. J. Harman, Lieut. R. E.
Survey of India.

October, 1878.

BRAHMAPUTRA RIVER

NEAR DIBRUGARH.

March 16*th*, 17*th*, 18*th*, 1878.

Computation of Discharge.

Length of "Run" = 75 feet. Magnetic Bearing of Section lines = 348½°.

Station Nos. at extremity of each portion. (1)	Depth at Stations. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth of portion for Computation. (5)	Observed flow of floats at Stations. (6)	Angle of Flow of Water for Computation. (7)	Mean time of Passage of floats over Run at Station. (8)	Time of Passage for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge per second through portion. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
left bank to 109	0 26	50	50	13	....	....	16	18	$50 \times 13 \times \frac{75}{18}$	650	2,708
109 to 106	26 29	70	70	27·50	255°	3°	16 15	15·5	$70 \times 27{\cdot}50 \times \sec. 3° \times \frac{75}{15{\cdot}75}$	1,925	9,327
106 to 103	29 34	55	55	31·5	255° 254°	4°	15 14·5	14·75	$55 \times 31{\cdot}5 \times \sec. 4° \times \frac{75}{14{\cdot}75}$	1,733	8,831
103 to 100	34 35	72	71	34·5	254° 254°	4½°	14·5 14·5	14·5	$71 \times 34{\cdot}5 \times \sec. 4\tfrac{1}{2}° \times \frac{75}{14{\cdot}5}$	2,450	12,709
100 to 97	35 31	62	61	33	254° 253°	5°	14·5 15·0	14·75	$61 \times 33 \times \sec. 5° \times \frac{75}{14{\cdot}75}$	2,013	10,275

97 to 85	31 27	61	60	30	253° 253°	5½°	15·0 14·5	14·75	$60 \times 30 \times \sec. 5\frac{1}{2} \times \frac{75}{14{\cdot}75}$	1,800	9,195
85 to 94	27 20	108	105	23·5	253° 248°	8°	14·5 15·0	14·75	$105 \times 23{\cdot}5 \times \sec. 8^\circ \times \frac{75}{14{\cdot}75}$	2,468	12,670
94 to 88	20 17	116	112	18·5	248° 247°	11°	15·0 14·5	14·75	$112 \times 18{\cdot}5 \times \sec. 11^\circ \times \frac{75}{14{\cdot}75}$	2,072	10,733
88 to 91	17 12½	257	252	14·75	247° 253°	8°	14·5 16·0	15·25	$252 \times 14{\cdot}75 \times \sec. 8^\circ \times \frac{75}{15{\cdot}25}$	3,717	18,460
91 to 112	12½ 11½	55	54	12·0	253° 255°	4½°	16·0 15·5	15·75	$54 \times 12 \times \sec. 4\frac{1}{2}^\circ \times \frac{75}{15{\cdot}75}$	648	3,095
112 to 121	11½ 9½	107	107	10·5	255° 266°	....	15·5 18·0	16·75	$107 \times 10{\cdot}5 \times \frac{75}{16{\cdot}75}$	1,123	5,031
121 to 122	9½ 5⅓	283	277	7·5	266° 266°	8°	18·0 20·0	19·0	$277 \times 7{\cdot}5 \times \sec. 8^\circ \times \frac{75}{19}$	2,078	8,281
122 to right bank in portions.											
(*a*) 122 station to 51 sounding.	5½ 3½	80	80	4·5	....	....	....	75	$80 \times 4{\cdot}5 \times \frac{75}{75}$	360	360

BRAHMAPUTRA RIVER,—*Continued.*

Station Nos. at extremity of each portion. (1)	Depth at Station. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth of portion for Computation. (5)	Observed flow of floats at Station. (6)	Angle of Flow of Water for Computation. (7)	Mean time of Passage of floats over Run at Stations. (8)	Time of Passage for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge per second through portion. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
(*b*) 51 sounding to 57 sounding.	3·5 2·0	277	275	2·75	....	....	....	75	$275 \times 2{\cdot}75 \times \frac{75}{75}$	756	756
(*c*) 57 sounding to near 60 sounding.	2·0 0·0	85	85	1·0	....	....	....	75	$85 \times 1 \times \frac{75}{75}$	85	85
(*d*) near 60 sounding to 66 sounding.	7·0 4·0	87	87	5·5	....	....	....	75	$87 \times 5{\cdot}5 \times \frac{75}{75}$	479	479
(*c*) 66 sounding to edge of sand.	3·25 0·0	80	80	1·5	....	....	....	75	$80 \times 1{\cdot}5 \times \frac{75}{75}$	120	120
									Total,....	24,477*	113,115*

Width of water 1,881 feet. Mean velocity 4·6 feet per second.

For the flood discharge, at ordinary high floods; add to measured discharge:

Width of portion in feet.		*Depth.*		*Vely. per second in feet*		*Discharge per sec. Cubic ft.*
900	×	16	×	7·5	=	108,000
900	×	16	×	6	=	87,000
2000	×	12	×	4·5	=	108,000
2000	×	12	×	4	=	96,000
1600	×	16	×	6	=	154,000
1800	×	14	×	4	=	101,000
1500	×	8	×	5	=	60,000

Total, = 714,000

The measured discharge = 714,000

Add for filtration through the sand, and volume of the unmeasured "Suti" (channel), *vide* memoir = 3,000

Total flood discharge exceeds, ... = 830,000 cubic ft. per second; mean flood velocity, 5 ft. per second.

Supfl. area of flood section above measured section = 139,600

" " measured section, ... = 24,477

Total superficial area of the section of river at ordinary flood level, .. = 164,000

The measured discharge was obtained at minimum level of the year. The effect of increased volume of river for a 3 ft. rise, above minimum level is—

	50	×	3	×	4·5	=	675
	960	×	3	×	5·5	=	15,840
	283	×	3	×	4	=	3,396
	610	×	3	×	3	=	5,490
Sand covered, ...	400	×	1·5	×	2	=	1.200
Intermediate "Suti,"	1600	×	3	×	4	=	19,200
" Sands,..	1500	×	2	×	3	=	9,000

Total increase in volume of river for a 3 ft. rise above minimum of year is = 54,800 cubic ft. per second.

Increase in area of section in superficial feet = 14·100 Sup. Ft.

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* *Vide* memoir: add 3000 ft. for filtration through an unmeasured side channel, which brings the discharge up to 116,000 cubic ft. per second.

UNITED DIHANG AND DIBANG RIVERS.

COMPUTATION OF DISCHARGE.

March 25th—27th of 1878.

Length of Run = 75 feet. Magc. Bearing of Section lines 280½.

Station Nos. at extremity of each portion. (1)	Depth at Stations. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth for Computation. (5)	Observed flow of floats at Stations. (6)	Angle of flows of water with Section lines for Computation. (7)	Observed mean time of passage of floats over Run at Station. (8)	Time of passage over Run for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge through portion per second. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Secs.		Sup. Ft.	Cub. Ft.
right bank to 59	0 3	196	193	1·5	.. 196°	6°	.. 42	63	$193 \times 1{\cdot}5 \times \sec. 6° \times \frac{75}{63}$	290	347
59 to 58	3 6·25	170	170	4·625	196° 192°	4°	42 26	34	$160 \times 4{\cdot}625 \times \sec. 4° \times \frac{75}{34}$	786	1,739
58 to 57	6·25 9·75	158	155	8·00	192° 191°	1°	26 19	22·5	$155 \times 8 \times \sec. 1° \times \frac{75}{22{\cdot}5}$	1,240	4,134
57 to 56 in	9·75 12·75	292			191° 193°		19 16				
2 portions	(*a*)	167	166	11.25		2°		18	$166 \times 11{\cdot}25 \times \sec. 2° \times \frac{75}{18}$	1,868	7,786
(*a*) & (*b*)	(*b*)	125	123	12·5		2°		16	$123 \times 12{\cdot}5 \times \sec. 2° \times \frac{75}{16}$	1,534	7,211

56 to 55	12·25 11·00	138	137	11·625	193° 195°	4°	16 15	15·5	$137 \times 11·625 \times \sec. 4° \times \frac{75}{15.5}$	1,593	7,725
55 to (a) 51 in	11 10·5	10.75	77	76	195°	5°	..	15	$76 \times 10·75 \times \sec. 5° \times \frac{75}{15}$	817	4,101
2 parts (b) (a) & (b)	10·33 11·5	11·00	147	146	195° 190°	2°	..	16	$146 \times 11·0 \times \sec. 2° \times \frac{75}{16}$	1,606	9,533
51 to 52	12 14	333	333	13	190° 190°	0	16 18·5	17·25	$333 \times 13 \times \frac{75}{17·25}$	4,329	18,822
52 to 50	14 13·25	295	295	13·625	° 190°	0	18·5 15	16·75	$295 \times 13·625 \times \frac{75}{16·75}$	4,019	17,997
50 to (a) 49 in	13·25 15·25	90	90	14·25	190° } 185° } 189°	1°	..	14	$90 \times 14·25 \times \sec. 1° \times \frac{75}{14}$	1,283	6,872
2 parts (b) (a) & (b)	15·25 12·25	150	148	13·75	..	3°	..	13·75	$148 \times 13·75 \times \sec. 3° \times \frac{75}{13.75}$	2,035	11,115
64 to 53	12·0 12·75	153	151	12·4	185° 185°	5°	13 15	14	$151 \times 12·4 \times \sec. 5° \times \frac{75}{14}$	1,872	10,069

UNITED DIHANG AND DIBANG RIVERS,—*Continued.*

Station Nos. at extremity of each portion. (1)	Depth at Stations. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth for Computation. (5)	Observed flow of floats at Stations. (6)	Angle of flows of water with Section lines for Computation. (7)	Observed mean time of passage of floats over Run at Stations. (8)	Time of passage over Run for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge through portion per second. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Secs.		Sup. Ft.	Cub. Ft.
	12·75				185°		15				
53		140									
to (*a*)	7·5				175°		50				
54		65	64	10·125		5°		16	$64 \times 10{\cdot}125 \times \sec\ 5^\circ \times \frac{75}{16}$	648	3,049
in 2 parts (*b*)		76	74	7.5·		10°		48	$74 \times 7{\cdot}5 \times \sec.\ 10^\circ \times \frac{75}{48}$	555	881
54 to left bank	7·5 0	180	3·5	..	..	..	..	75	$180 \times 3{\cdot}5 \times \frac{75}{75}$	630	630
Total width of water 2,510 ft. Mean velocity in ft. per second 4·4 ft.									Total,	25,105	110,011

For Flood Discharge at the ordinary High Floods add :

300 × 13 × 5 = 19,500
2500 × 15 × 7 = 262,500
600 × 14 × 5 = 42,000
200 × 16 × 6 = 19,200
800 × 13 × 5 = 52,000
200 × 9 × 4 = 7,200

402,400
The measured Discharge 82,652

Flood Discharge of Dihang + Dibang Rivers 485,000
From this subtract Flood Discharge of Dibang 122,483

Flood Discharge of Dihang 362,517

	Sup. Feet.	
Area of Flood Section above measured Section	65,200	
Add area of Section at minimum level of year (see below)	18,883	
Total area of Flood Discharge of united Dihang and Dibang,......	84,000	The mean velocity is 5·7 ft. per second.

At time of measurement the river was 3 ft. above minimum level of year.
The increased volume above minimum discharge due to this rise of 3 ft. is

$170 \times 3 \times 3{\cdot}5 = 1{,}785$
$654 \times 3 \times 5{\cdot}0 = 9{,}810$
$628 \times 3 \times 4 = 7{,}536$
$391 \times 3 \times 5 = 5{,}865$
$65 \times 3 \times 5 = 975$
$76 \times 3 \times 2 = 456$
$90 \times 3 \times 1 = 270$

	26,697	
	347	Add measured volume of water passing over sands not covered at minimum.
	315	
Increase in volume due to a 3 ft. rise over minimum	27,359	
The measured Discharge	110,011	
	82,652	Discharge of Dihang + Dibang at minimum.
The minimum discharge of Dibang	27,200	
Minimum Discharge of Dihang ..	55,452	Cubic ft. per second.

	Sup. Feet.
The increase in area of Section for a 3 ft. rise over minimum level is	6,222
The measured area of Section is	25,105
Thus the area of Section at minimum, of Dihang + Dibang is..	18,883

And mean velocity is 4·3 ft. per second.

DIBANG RIVER.

DISCHARGE COMPUTATIONS.

March 27th, 1878.

Length of Run = 50 ft. Magnetic Bearing of Section lines 359½°.

The Station Nos. at extremity of portions. (1)	Depth at Stations. (2)	Length of portions. (3)	Length of portion for Computation. (4)	Depth for Computation. (5)	Observed flow of floats at Stations. (6)	Angle of flow of water with Section line for Computation. (7)	Mean time of passage of floats over Run at Stations. (8)	Time of passage over Run for Computation. (9)	Multiplication. (10)	Area of portion in Superficial Feet. (11)	Discharge per second through portion. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Secs.		Sup. Ft.	Cub. Ft.
right bank to 32	0 16	33	33	10	.. ..	..	11 0	12·0	$33 \times 10 \times \frac{50}{12}$	330	1,375
32 to 51	16 17	68	68	16·5	271° 268°	..	11·0 10·5	10·75	$68 \times 16{\cdot}5 \times \frac{50}{10{\cdot}75}$	1,122	5,180
31 to (a) 33 in 2 parts (a) (b)	17 17·5	70	70	17·25	..	..	..	10·5	$70 \times 17{\cdot}25 \times \frac{50}{10{\cdot}5}$	1,208	5,750
(b)	17·5 14	146	144	15·75	668° 264°	3°	..	10·5	$144 \times 15{\cdot}75 \times \sec 3^\circ \times \frac{50}{10{\cdot}5}$	2,268	10,815
33 to 30	13 13	62	61	13·0	264° 265°	5°	10·5 11·5	10·0	$61 \times 13 \times \sec 5^\circ \times \frac{50}{11}$	793	3,618

30 to 29	13 10·25	252	250	11·6	265° 266°	4°	11·5 12·5	12·0	250 × 11·6 × sec. 4° × $\frac{50}{12}$	2,900	12,113
29 to 34	10·25 10·00	17	17	10·13	266° 264°	4½°	12·5 12·5	12·5	17 × 10·13 × sec. 4½° × $\frac{50}{12·5}$	172	691
34 to 35	10·0 10·25	88	87	10·13	264° 264°	5½°	12·5 13·5	13·0	87 × 10·13 × sec. 5½° × $\frac{50}{13}$	881	3,405
35 to 36	10·25 6·0	117	116	8·13	264° 268°	3	13·5 15·0	14·28	116 × 8·13 × sec. 3° × $\frac{50}{14·25}$	943	3,314
36 to 37	6·0 5·0	46	46	5·5	268° 270°	..	15·0 16·0	15·5	46 × 5·5 × $\frac{50}{15·5}$	253	816
37 to left bank.	5·0 0·0	49	49	2·5	..	..	16·0	20·0	49 × 2·5 × $\frac{50}{23}$	122	306
									Totals, ..	10,992	47,383

Width of Water = 950 feet. Mean Velocity = 4·3 feet per second.

DIBANG RIVER.

For Flood Discharge of Dibang River.
add to the measured Discharge.

Length of portion in feet.		*Depth.*		*Velocity in Ft. per second.*		
740	×	10	×	7	=	51,800
210	×	10	×	5	=	10,500
400	×	8	×	4	=	12,800
						75,100
		The measured Discharge,			=	47,383
Discharge of Dibang River during ordinary High flood,					=	122,483, Cu. ft. per second.

The area of flood Section above level of water during measurements, = 12.700 S. Ft.
add measured Section, = 10,992

Area of ordinary High Flood section, = 23,692 S. Ft.

Hence mean Velocity of flood is 5·2 ft. per second.

At the time of measurement of Discharge the river was 5 ft. above minimum of year; the volume of a 5 ft. rise over the minimum volume of river during the year is—

379 × 5 × 5 = 9,475
520 × 5 × 4 = 10,400
19,875
add 306 measured volume of water passing over sands covered by a 5 ft. rise above low level of the year.
20,181—Total increase in volume of the river due to a 5 ft. rise above lowest level of the year.
47,383 observed Discharge.
27,202 Cu. ft. Discharge of Dibang river at minimum.

The area of Section is 6,375 Sup. Ft. and Mean velocity = 4·2 ft. per second.

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Survey of India.

October, 1878.

BRAHMAPUTRA RIVER ABOVE SADIYA.

COMPUTATION OF DISCHARGE.

April 3rd to 6th of 1878.

Length of Run = 50 feet — Magnetic Bearing of Section lines 318½°.

Station Nos. at extremity of each portion. (1)	Depth at Station. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth of portion for Computation. (5)	Observed flow of floats at Station. (6)	Angle of flow of water for Computation. (7)	Mean time of passage of floats over Run at Station. (8)	Mean time of passage for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge per second through portion. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
right bank to 62	0 14	110	105	9	parallel to right bank.	8°	9·5	10	$105 \times 9 \times \sec. 8^\circ \times \frac{50}{10}$	045	4,771
62 to 63 in 2 parts	14 13·5	143					9·5 10·0				
(*a*)	14 18	98	96	16		8°		9·5	$96 \times 16 \times \sec. 8^\circ \times \frac{50}{9 \cdot 5}$	1,536	8,164
(*b*)	18 13·5	47	47	15·75		8½°		10·0	$47 \times 15 \cdot 75 + \sec. 8\tfrac{1}{2}^\circ \times \frac{50}{10}$	740	3,742
63 to 66 in 2 parts	13·5 9·25	285			220° 220°	8½°	10·0 10·5				
(*a*)	13·5 13	13·25 (5)	220 (3)	215 (4)		8½°		10·2	$215 \times 13 \cdot 25 \times \sec. 8\tfrac{1}{2}^\circ \times \frac{50}{10 \cdot 2}$	2,846	14,120
(*b*)	13 9·25	65	64	11·13		8½°		10·4	$64 \times 11 \cdot 13 \times \sec. 8\tfrac{1}{2}^\circ \times \frac{50}{10 \cdot 4}$	712	3,463

BRAHMAPUTRA RIVER ABOVE SADIYA.—*Continued.*

Station Nos. at extremity of each portion. (1)	Depth at Station. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth of portion for Computation. (5)	Observed flow of floats at Stations. (6)	Angle of flow of water for Computation. (7)	Mean time of passage of floats over Run at Stations. (8)	Mean time of passage for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge per second through portion. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
66 to 67	9·25 6·75	150	147	8	220° 224°	6½°	10·5 14·5	12·5	$147 \times 8 \times \sec. 6\frac{1}{2}^\circ \times \frac{50}{12 \cdot 5}$	1,176	4,734
67 to 64	6·75 4·00	141	141	5·3	224° 235°	....	14·5 15·0	14·75	$141 \times 5 \cdot 3 + \frac{50}{14 \cdot 75}$	747	2,533
64 to 65	4·0 3·75	247	240	3·5	235° 240°	10°	15·0 17·0	16·0	$240 + 3 \cdot 5 \times \sec. 10^\circ \times \frac{50}{16 \cdot 0}$	840	2,665
65 to 70	3·75 5·25 midway 3·25	278	270	4	240° 240°	12½°	17·0 17·0	17·0	$270 \times 4 \times \sec. 12\frac{1}{2}^\circ \times \frac{50}{17}$	1,080	3,254
70 to 71	3·25 1 midway 4·0	290	280	2	240° 243°	13½°	17·0 15·0	16·0	$280 \times 2 \times \sec. 13\frac{1}{2}^\circ \times \frac{50}{16}$	560	1,800
71 to 69	4·0 4·25	78	76	4	243° 238°	12°	15·0 14·0	14·75	$76 \times 4 \times \sec. 12^\circ \times \frac{50}{14 \cdot 75}$	304	1,054

69 to 72	4.25 5·50	230	227	4·8	238° 237°	9°	14·5 14·0	14·25	$227 \times 4{\cdot}8 \times \sec. 9^\circ \times \frac{50}{14{\cdot}25}$	1,090	3,871
72 to 68	5·5 5·0	110	108	5·25	237° 235°	7½°	14·0 16·5	15·25	$108 \times 5{\cdot}25 \times \sec. 7\tfrac{1}{2}^\circ \times \frac{50}{15{\cdot}25}$	567	1,875
68 to 73	5 5	176	174	4·75	235° 240°?	8°	16·5 15·0	15·8	$174 \times 4{\cdot}75 \times \sec. 8^\circ \times \frac{50}{15{\cdot}8}$	827	2,641
73 to 74	5 5	210	208	5	240°? 225°	..	15·0 15·2	15·1	$208 \times 5 \times \frac{50}{15{\cdot}1}$	1,040	3,444
74 to 75	5 3·5	220	218	4·25	225° 227°	2½°	15·2 16·0	15·6	$218 \times 4{\cdot}25 \times \sec. 2\tfrac{1}{2}^\circ \times \frac{50}{15{\cdot}6}$	927	2,972
75 to left bank	3·5 0	155	153	3·0	227°	..	16·0	20·0	$153 \times 3{\cdot}0 \times \frac{50}{20}$	459	1,148
Width of water 2790 feet.						Mean velocity = 4 ft. per second.			Totals,	16,396	66,251

For Discharge at ordinary High Flood add to the measured Discharge :—

width of portion in Feet.		depth.		velocity.		cubic ft. per second.
688	×	13	×	7	=	62,608
1,374	×	13	×	6	=	107,172
600	×	13	×	6	=	46,800
155	×	13	×	5	=	10,075
					Total,	226,655
				The measured Discharge,	=	66,251

Total Discharge at ordinary high floods, = 293,000

From this subtract flood discharge of Tengapáni and Noa Dihing Rivers, ... = 53,000

Flood discharge of Brahmaputra + Digáru rivers, ... = 240,000

At time of measurement the river was 3 ft. above minimum level of the year, the increase in volume due to this rise is

105	× 3	×	5	=	1,575
143	× 3	×	5	=	2,145
285	× 3	×	5	=	4,275
150	× 3	×	5	=	2,250
140	× 3	×	4	=	1,680
240	× 3	×	3	=	2,160
76	× 3	×	4	=	912
227	× 3	×	3	=	2,724
108	× 3	×	4	=	1,296
600	× 3	×	4	=	7,200
					26,217

Add measured volumes of portions of section which are covered by the 3 ft. rise, } 1,800
1,148
3,254

Total increase in volume, due to a 3 ft. rise above minimum level } 32,419 cubic ft. per second.

Area of Flood section over measured section, ... = 36,721 S. Ft.

Add measured section, ... = 16,396

Area of Flood section, ... = 53,017 S. Ft. The mean velocity of Flood = 5·5 ft. per second.

Measured Discharge, ... = 66,251

Subtract volume of 3 ft. rise, ... = 32,419

Discharge of the Brahmaputra + Digáru + Noa Dihing + Tengapáni Rivers at their minimum level, ... = 33,832 The sectional area = 8,228 S. Ft. and mean velocity 4·1 ft. per second.

Subtract Noa Dihing + Tengapáni, their minimum discharge, ... = 3,000

30,800 Cubic feet is the minimum Discharge of Brahmaputra + Digáru rivers.

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